Ohio State Soil Balancing Project Summary

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What is Soil Balancing?

Soil balancing is a soil management strategy founded on base cation saturation ratio (BCSR) theory. BCSR theory prescribes the use of soil amendments, commonly gypsum and high-calcium lime, to achieve an ideal ratio of the base cations calcium, magnesium, and potassium (Ca, Mg, K). The commonly preferred ratio is 65% Ca, 10% Mg, and 5% K.

Why the Interest?

The sparse academic research on soil balancing has been unable to support its effectiveness. Despite this fact, our conversations with farmers in recent years suggested that soil balancing was being widely used. In our 2018 survey of organic corn farmers in Ohio, Pennsylvania, Indiana, and Michigan, we found that about half of the 859 respondents reported using soil balancing on their farms. (See Figure 1).

Survey respondents who used soil balancing reported many improvements which they attributed to soil balancing. More than 70% reported improvements in soil quality, nutrient availability, crop quality and yield, soil biological activity, and infiltration/drainage. A smaller number (40-50%) reported less weed pressure, and less soil crusting and soil compaction.

In addition to investigating these claims, we also wanted to examine potential economic and production drawbacks of soil balancing. Farmers who use soil balancing are spending an average of $50/acre on Ca-rich amendments that may not be needed for crop nutrition. Researchers were also concerned that excess levels of Ca may interfere with the availability and uptake of other essential plant nutrient cations such as K and Mg.

After reviewing the published studies on soil balancing and speaking directly with farmers, we found substantial gaps in understanding between farmers and researchers. By working with farmers, crop consultants, and the scientific community we hope to understand the practices and goals of soil balancing so that better recommendations, studies, and explanations might be developed.

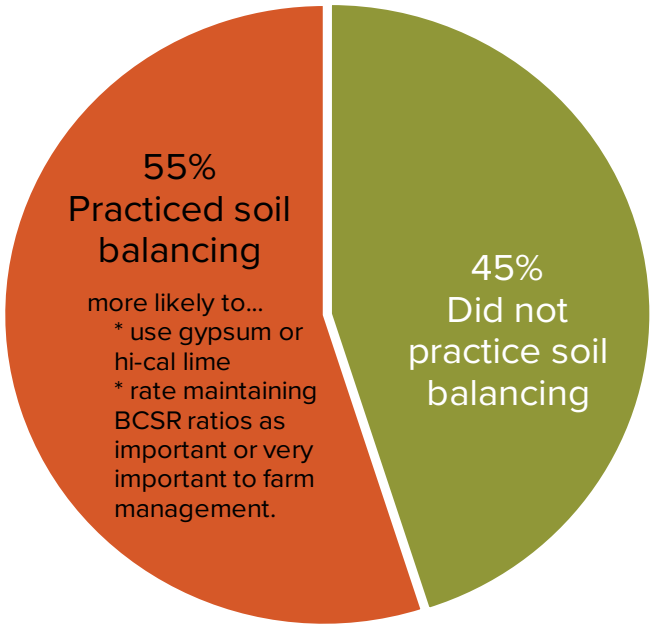

Figure 1. Percent of Organic Corn Grower Survey Respondents Who Reported Using Soil Balancing. A little over half of our survey respondents reported using soil balancing on their farms. In addition to providing a definition of the practice in the survey, we also checked to see if self-described soil balancers used amendments and practices consistent with our definition.

What We Did

To improve our understanding of how and why farmers use soil balancing, we surveyed and interviewed organic farmers about soil balancing and related topics. With guidance from a committee of farmers and consultants, we created field experiments to address some of the shortcomings in the previous scientific studies conducted on soil balancing. We measured impacts on soil health and crop quality, in addition to yield. We lengthened the study period when possible, and conducted studies on working organic farms as well as research station fields. In all, our team implemented research trials at 22 research sites—18 on-farm and 4 on-station. Sites supported various crops including grain crop-forage rotations and vegetables. We applied different amendments to raise or lower Ca:Mg ratios and then measured a wide range of outcomes over two to four growing seasons.

Results

We were able to change the Ca:Mg ratio to the desired range in a four-year period. However, we saw *no significant effects on yield, crop quality, or soil quality indicators.* By using various treatments to increase Ca saturation, we could distinguish effects of changing pH vs. Ca:Mg ratio. Our results confirm that *pH is a stronger influencing factor on crop yield than Ca:Mg ratio.*

We did observe that soil penetration resistance decreased with increased Ca:Mg ratios for some of the sites in 2018. Also in 2018, we recorded two research station sites where populations of two foxtail species decreased as the Ca:Mg ratio increased. Similar results were seen in on-farm experiments in 2018 but were not consistent across most sites.

These *results suggest soil balancing may have a positive effect on soil structure,* but only on specific soils. Interviews with soil balancing consultants offered agreement with this thinking. Some consultants claimed soil balancing works best on clay soils with a CEC of more than 8-10 meq/100 g.

Our study included several on-farm sites with CEC readings below 10 meq/100 g. We did note K saturation ratios below the recommended 5% in the soil on some of these sites, along with deficiency levels of K in the plant tissue, which we attributed to overuse of Ca amendments.

Economic analysis of self-reported soil amendment expenditures and crop yields from our survey suggests that farmers using high calcium amendments experience higher corn yields, but higher expenditures offset increased revenues, leading to similar net returns.

Recommendations

For now, we are unable to officially encourage or discourage the use of soil balancing. The following recommendations are based on field trials and on the experience and advice of our stakeholder advisory committee.

- *Soil test data is critical* to making informed decisions about managing Ca:Mg ratios.
- *Watch your pH if using lime.* Gypsum is a better choice to change your Ca saturation ratio without affecting pH, and it also provides sulfur.
- *Soils with a CEC below 10 meq/100 g may develop K deficiencies.* In soils with a low holding capacity for cations, excess Ca can quickly lead to deficiencies of K, and possibly Mg. We did observe this in on-farm sites.
- *Consider economic factors.* On soils with higher CEC, more time and amendments will be needed to increase the Ca:Mg ratio. Depending on the amount of change needed and the value of your crop, using soil balancing may be cost prohibitive.
- *Any time you try a new practice, monitor the results.* If possible, try using the new practice on only part of your farm and compare it with a similarly managed area to see if the new technique is making a positive contribution over time.

Future Work

We plan to continue studying our long-term sites to see if more consistent positive effects emerge in the coming years. More importantly, we'd like to continue observing soil balancing on additional organic farms. Partnering with University of Wisconsin, we've requested additional funding for a major on-farm soil balancing study. We will examine how BCSR treatments affect soil and crop quality on a variety of soils with different CEC, clay content, and initial Ca:Mg ratios. We hope to further investigate the economic impacts of soil balancing and create recommendations that researchers, educators, and farmers can trust and use.

Input from the organic farming community was critical to this project and will continue to be essential in future work. Our stakeholder advisory committee was integral to setting research goals and methods, selecting on-farm test sites, and discussing results. Extension personnel are increasing their use of participatory research, realizing this approach keeps research relevant, reflects realistic farm conditions, and benefits from the knowledge and experience of farmers. For more information, visit **go.osu.edu/sb** or contact one of our current team members.

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